Relative rates of the H-D substitution reaction in solid methanol

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Methanol molecule was found to be highly deuterium-fractionated in molecular clouds. This discovery has fascinated astrochemists because the fractionation process in molecular clouds can also be a potential explanation of high deuterium (D) fractionation found in comets and the solar system.

To date, several models have been proposed to explain the D fractionation. Gas-phase models are difficult to reproduce the D-enrichment, particularly, for multi-deuterated methanol, while the results of some gas-grain models are consistent with the observations fairly well. However, the gas-grain models require many assumptions regarding the grain surface reactions. Then, the experiments on the surface reaction have been highly desirable.

In this context, our group performed the experiments on the formation of deuterated methanol on a cold surface and revealed that a key route for the fractionation is not successive addition of H and D to CO as previously considered but H-D substitution in solid CH3OH on icy grains [1]. We report the results of further experiments on the deuteration of CH3OH using a cold atomic D beam. Methanol-dn-1 (n=1-3) was exposed to D atoms at 10 K and the products, methanol-dn, were measured. The detail information of reaction rates will be presented.

Reference [1] Nagaoka, A., Watanabe, N., & Kouchi, A. 2005, ApJ., 624, L29.